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Lithium Polymer Electrolyte Battery, Electrochemical Behavior of Cathode Materials

by

B. Scrosati, B. Selvaggi, B.B. Owens, and M.Z.A. Munshi

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Corrosion Research Center
Department of Chemical Engineering and Materials Science
221 Church St. SE
University of Minnesota
Minneapolis, MN 55455
and
Department of Chemistry
University of Rome
Rome, Italy

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B. Scrosati, B. Selvaggi, B.B. Owens, and M.Z.A. Munshi

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Thin layer, lithium polymer electrolyte batteries have reached an advanced stage of development. All prototypes use insertion compounds of various composition and structures as the active cathode material. Titanium disulphide, vanadium oxide and lithium vanadium bronze, respectively, were tested under comparable conditions as the active electrode materials. The characteristics of the interfaces were examined by cyclic voltammetry, impedance spectroscopy and intercalation-deintercalation cycling and the results of this study are reported in this work.

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B. Scrosati and A. Selvaggi
Dipartimento di Chimica
Universita di Roma, La Sapiensa
Rome, Italy
and
B.B. Owens and M.Z.A. Munshi
Corrosion Research Center,
University of Minnesota,
Minneapolis, Minnesota 55455

Thin layer, lithium polymer electrolyte batteries have reached an advanced stage of development. Various industrial and academic laboratories have been successful in developing high-performance prototypes of such batteries.

All these prototypes use insertion compounds of various composition and structures as the active cathode material. Lithium polymer electrolyte batteries based on the layer-structure titanium disulphide TiS_2 are currently under development at the Hydro-Quebec Laboratories in Canada (1). Batteries based on the tunnel-structure vanadium oxide V_6O_{13} have been investigated at the Harwell Laboratory in the UK (2) and at the Mead Imaging Laboratories in the U.S. (3) as well as tested in one of our laboratories (4). Finally, the feasibility of the lithium vanadium bronze LiV_3O_8 as the cathode material in lithium polymer electrolyte cells has been determined by us (5) as well as by other investigators (6).

There are various advantages in using intercalation compounds as the positive in polymer batteries, including fast electrochemical processes (7), high-specific energy projections (8) and favorable design and manufacturing cost forecasts (9). However, while these compounds behave very satisfactorily in organic, liquid electrolyte systems, they present a major problem when used in polymer electrolyte cells. A progressive decline in cell capacity on cycling is observed with cathode limited designs.

This effect, which has been generally observed, is not easily explained, since the insertion of lithium in the cited host compounds is basically a very reversible process and thus prolonged cycle is expected for related electrochemical cells. On the other hand, the observed decay in capacity on cycling is a crucial aspect in the technology of polymer electrolyte batteries and in the attempt to clarify its origin and its practical influence, we have carried out an analysis of the electrode/polymer electrolyte interfaces.

Titanium disulphide, vanadium oxide and lithium vanadium bronze, respectively, were tested under comparable conditions as the active electrode materials while the complex formed by poly(ethylene oxide), PEO, and lithium perchlorate, $LiClO_4$, in the preferred composition O/Li ratio equal to 8, was used as the standard polymer electrolyte.

The characteristics of the interfaces were examined by cyclic voltammetry, impedance spectroscopy and intercalation-deintercalation cycling and the results of this study are reported in this work.

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References

1) M. Gauthier, 1st International Symposium on Polymer Electrolytes St. Andrews, Scotland, June, 1987.
2) A. Hooper, "Polymer Electrolyte-Based Lithium Batteries - A Review", Abstract No 20, Extended Abstracts of the National Meeting of the Electrochemical Society, October 1988.
3) D. Fauteux, 2nd International Symposium on Polymer Electrolytes, Siena, Italy, June 1989.
4) M.Z.A. Munshi and B.B. Owens, Solid State Ionics, 20, 41 (1988).
5) L. Bonino, M. Ottaviani, B. Scrosati and G. Pistoia, J. Electrochem. Soc., 13, 165 (1987).
6) K. West, B. Zachav-Christiansen and T. Jacobsen, J. Power Sources, 14, 165 (1987).
7) B. Scrosati, British Polymer Journal, 20, 219 (1988).
8) B. Scrosati, in "Polymer Electrolyte Review I", J.R. MacCallum and C.A. Vincent, Eds, Elsevier Applied Science, London, 1987, p. 315-346.
9) B.B. Owens, EPRI AP-5218 Report, June 1982.